AIR WAR COLLEGE

AIR UNIVERSITY

FASTER & CHEAPER:

CREATING A CULTURE OF INNOVATION FOR AFRL

INTELLECTUAL PROPERTY

by

Debra Luker, Colonel, United States Air Force

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Advisor: Dr. Roy F. Houchin II

DISCLAIMER

The views expressed in this academic research paper are those of the author and do not reflect the official policy or position of the US government, the Department of Defense, or Air University. In accordance with Air Force Instruction 51-303, it is not copyrighted, but is the property of the United States government.

Biography

Colonel Debra Luker is assigned to the Air War College, Air University, Maxwell AFB, Alabama. Colonel Luker received her commission in the United States Air Force upon graduation from the United States Air Force Academy in June 1994, with the honor of being named the Top Student Researcher in the Department of Aeronautics. In the master's degree program at the Air Force Institute of Technology (AFIT), she specialized in Aircraft Aerodynamics and Robotics. Following graduation from AFIT, she worked at Wright Laboratory and the Air Force Research Laboratory on escape system technologies and international cooperative programs. Just before entering the Air Force's Funded Legal Education Program, she was the Director of the Laboratory Acquisition Management Course at the Systems Acquisition School, Brooks AFB, Texas. Upon graduating from St. Mary's University School of Law in 2002, Colonel Luker joined the United States Air Force JAG Corps. She served at Eglin Air Force Base, Florida, as Chief of Legal Assistance, Claims, and Military Justice; at Kunsan Air Base, Republic of Korea, as Deputy Staff Judge Advocate; at the Air Force Legal Operations Agency as an Aviation and Admiralty Law Attorney and Executive Officer to the Air Force Legal Operations Agency Commander; at Andrews Air Force Base, Maryland, as Deputy Staff Judge Advocate; at Headquarters Air Force Materiel Command as Chief of Administrative Law and Chief of Military Justice; and three years as Staff Judge Advocate at Seymour Johnson Air Force Base, North Carolina. In addition, Colonel Luker has deployed to Afghanistan as Chief of Fiscal Law and Chief of Military Justice for Combined Joint Task Force-76 and to Manas Air Base, Kyrgyz Republic, as Staff Judge Advocate.

Abstract

AFRL must find a way to provide new technology to its customers faster and cheaper. The way to achieve this goal is to create a culture of innovation within AFRL. A review of existing programs in the government and private industry provides some headway, but does not address the main component of changing an organization's culture to one embracing or creating self-sustaining innovation. In addition to considering this review of other innovation programs and research on innovation literature, AFRL leadership must promote breakthrough successes, provide personnel with policies and facilities to stimulate creativity, as well as measure and analyze these programs to determine what aspects should continue or change. Key to this cultural change should be creating an AFRL innovation challenge, selecting an innovation project, creating an Innovation Center, fostering support of innovation throughout AFRL, and establishing a way to measure success of innovation initiatives to inform what programs should continue, terminate, or change.

"If you always do what you always did, you will always get what you always got."

- Albert Einstein[1]

Introduction

To stay ahead of potential adversaries, the Air Force must continuously innovate; otherwise unexpected adversaries will bypass U.S. defenses and defeat existing U.S. countermeasures.[2] The Air Force Research Laboratory (AFRL) is the organization charged with performing scientific and technical (S&T) research and development (R&D) for the Air Force, and therefore must institutionalize this emphasis on innovation. However, structured procedures have limited the type of innovative thinking and inhibit the creativity required to produce new technology faster and cheaper. Since at least 2006, AFRL has endeavored to encourage innovation; yet a persistent feeling more could be done remains.[3] As a first step to resource their dilemma, AFRL should define what type of innovation they seek. Innovation should be viewed as a new idea as well as the use of the new idea to solve a problem or to create another invention to solve a problem.[4] Thus, innovation becomes more than the creation of good ideas; it's the application of those good ideas to create better products. To accomplish this, AFRL should create a climate to produce groundbreaking changes rather than the typical steady state change, becoming more than an organization making only incremental improvements on ideas and products.[5] In order to create a culture of innovation, AFRL leadership must promote breakthrough successes, provide personnel with policies and facilities focused on stimulating creativity, as well as measure and analyze the programs to determine what aspects should continue or change.

"The future cannot be predicted, but futures can be invented." – Dennis Gabor[6]

Creating an Innovation Culture by Promoting Breakthrough Successes

Current Air Force R&D culture values the technical paper, report, book chapter, and PowerPoint. Their R&D culture has lost the vision of believing technology means something. Consequently, AFRL needs to recapture a pioneer spirit in order to change their culture. To accomplish this, it is worthwhile to explore innovation programs from other organizations to gain ideas to put into practice at AFRL.[7]

Google Innovations

Google focuses on nurturing a culture committed to innovation and risk taking; it also advocates its people are what make Google what it is.[8] Google hires a diverse range of smart and determined employees, concentrating on their abilities rather than their experience.[9] The company focuses on maintaining an open culture where everyone is a contributor and supports the sharing of ideas and opinions.[10] It encourages interaction across the company, including discussions on issues not work-related.[11]

Besides their personnel practices, Google is also known for their unique facilities, designed to foster teamwork and creativity.[12] Instead of opaque walls, glass is used to divide the workspace, thus cutting ambient noise and allowing sunlight to filter through the building. [13] Google also uses paint colors to promote productivity, as visually complex color schemes promote work performance.[14] Also, employees are encouraged to personalize their workspaces, including bringing their dogs into the building.[15] Google even provides breakfast, lunch, dinner, snacks, juice, and coffee for free.[16] In addition, there are available gym facilities, laundry and dry cleaning services, medical staff, massage therapists, an in-house daycare, ping pong, billiards and foosball game tables, video games, treadmill desks, bicycles, garden spaces, as well as nap

pods.[17] Every work week also earns employees the opportunity to work on pet projects for a full

day in the Google "20 percent time" program.[18] Google uses these benefits to constantly

encourage self-expression and teamwork.

When reviewing these approaches, some benefits are similar to those offered on a

military installation, but Google is a commercial company and all their methodologies may not

translate to Department of Defense (DoD) conventions. However, Google has several

approaches worth considering, even though they differ from standard federal government

methods.

Central Intelligence Agency In-Q-Tel

The Central Intelligence Agency (CIA) started In-Q-Tel in 1999.[19] In-Q-Tel is an

independent non-profit corporation; it provides initial funding, along with other venture capitalist

investors, to start-up companies, allowing In-Q-Tel to create and transform new technology into

products fit for Intelligence Community needs. The ratio is normally $1 from In-Q-Tel for every

$11 invested by venture capitalists.[20]

In-Q-Tel relies on client supporters to champion a technology and make the

determination to invest in particular projects. Once a need is determined, then In-Q-Tel reviews

hundreds of start-up companies. Of about 800 companies reviewed, almost 130 are typically

determined to be of interest to client supporters; then only about 20-25% of those 130 companies

receive investments, with a goal of having fielded products within six months to two years.

Although not all supporters persist with the technology until it is fielded, examination of 140

case studies of technological innovations finds client participation is consistently confirmed as

the most important factor for success.[21]

Yet, while In-Q-Tel arguably enhances innovation overall, it does not necessarily improve innovation organically within the CIA. If AFRL were to create an entity similar to In-Q-Tel, individuals should first review the DoD pilot program with In-Q-Tel through the DoD Global Operations Joint Staff J-39 to avoid creating a redundant or conflicting program. Also, an In-Q-Tel model cannot be used for technologies the government does not want the public to know about, as the startup companies are more interested in commercial applications than potentially less-profitable government niche applications (and receive more funding as a consequence).[22] Therefore, In-Q-Tel is more of a program to fuel private R&D than encourage innovation within a government organization.[23]

National Science Foundation I-Corps Program

Started in July 2011, the National Science Foundation (NSF) I-Corps created a mentorship team of volunteers from private industry technology developers, business leaders, and venture capitalists.[24] These mentors partner with academic scientists to help them focus on converting their technological innovations into a commercial product.[25] Their goal is to build a "national ecosystem for innovation."[26] After a 6-month curriculum and $50,000 grant from NSF, the most common vehicle for the I-Corps participants to use for entering the commercial market is a start-up company.[27]

The mentorship and partnership aspects of this program are very beneficial. However, the focus is on creating commercialized products. Their ultimate objective is for profitability based on what the market needs rather than a goal of breakthrough innovation. The disadvantage is this focus could create the same type of slow, incremental development of technology based on a limited vision of what the customer thinks is possible, rather than a truly revolutionary innovation following a fundamentally different path than what is commonly expected.

Department of Homeland Security Commercialization Office

The Department of Homeland Security (DHS) states it "promotes technology transfer with industry, state and local governments, academia and other federal agencies."[28] To achieve this goal, the DHS Commercialization Office has programs similar to those of other small business initiatives throughout the government. For example, the Small Business Innovation Research Program awards money to small businesses in order to rapidly commercialize and deliver prototypes to DHS operatives in the field.[29]

The benefits of this program are its emphasis on speed and a willingness to accept a prototype rather than fully-tested complete products. This approach differs significantly from the current overall Air Force culture where systems are expected to work perfectly upon their first day in the field. Compiled with the fact the current Air Force mindset is to keep aircraft in the active fleet for decades, R&D time and costs for one program can increase significantly. This cultural process creates a self-feeding downward spiral, because now that the system took so long to develop and cost so much, the Air Force wants it to last longer. In contrast, DHS's ability to adjust technology to particular circumstances under field conditions is ideal; it eliminates the possibility of completing an entire product then learning it is incompatible with the client's needs or operating procedures, and it gets new products, and delivers new products to the field faster.[30]

AFRL Entrepreneurial Opportunities Program

In 2015, as a step toward encouraging innovation with a focus on attracting and retaining talented employees, AFRL instituted a program allowing civilian employees to take as long as a one-year sabbatical while still being paid their full salary.[31] Then, at the end of the year, the employees can either return to AFRL or leave government employment. This program is run

based on the Department of Energy's Sandia National Laboratories' Entrepreneurial Separation to Technology Transfer program.[32] Under the AFRL program, "employees seek to obtain a license from AFRL for AFRL-developed intellectual property in order to start his or her own technology-based business, seek to join an existing technology-based business with an AFRL license in order to provide technical support, or seek to start or expand a technology-based business using technical expertise developed at AFRL."[33]

The biggest difficulty of this program is measuring "success." Comparable programs have used the number of applicants as a justification of success, but the number of applicants does not correlate to the goals of the program.[34] A better method would be to measure how the AFRL technologies used in commercial products benefit national security and promote economic prosperity. Also, initial employment surveys may be needed to determine if higher quality employees are applying to AFRL because of this program. The drawback is AFRL may lose its best talent under this system, gaining in return only licensing fees and recruitment tools.[35] Until AFRL determines useful measures of success, it is unknown whether this program will promote breakthrough innovations or continue the typical incremental successes.

"Organizations, by their very nature are designed to promote order and routine.

They are inhospitable environments for innovation." - Theodore Levitt[36]

Providing Personnel with Policies and Facilities To Stimulate Creativity

All of these programs promote an innovation culture across the U.S. government. A common theme in the programs is an innovation culture promotes interaction of its personnel with others to enhance creativity and ensure corresponding resources, as well as rewards, are in

place for taking risks.[37] Thus, an organization can build a culture of innovation through changes to its policies related to leadership, personnel, and facilities.

Leadership

Leadership, consisting primarily of the AFRL Commander but also all supervisors and managers, has a critical role in creating this innovation culture.[38] In fact, their attitude controls the climate of the entire organization; management's attitude is crucial.[39] Thus, they must portray an attitude supporting promotion of innovative ideas and provide the resources to pursue those ideas.[40]

Leadership must look at positive and negative impacts created by the organization's structure, communication procedures, reward and recognition systems, training policies, as well as measurements of success.[41] The top factors needed to enhance creativity are freedom to work on areas of greatest interest, recognition and appreciation, broad contacts with stimulating colleagues, and encouragement to take risks.[42] Thus, an organization boosts ingenuity by allowing employees to work on projects of interest to them, creating innovation awards and rewards, improving collaboration, and establishing an attitude accepting of prudent risks and failures.[43]

Similarly, supervisors must set aside time to allow employees to work on projects they are passionate about.[44] Many scientists and engineers have a passion for an idea, but do not have the time, personal expertise, and support to create an innovative technological breakthrough, even though they have been playing with their concepts for years.[45] If they are provided the missing resources, then shared goals are created between the organization and its personnel, inspiring loyalty as well as an increase in morale and innovative ideas.[46]

To foster this creative environment, the organization must then implement positive incentives and eliminate or reduce negative incentives to innovation.[47] Part of this attitude needs to include the flexibility to allow changes to the environment, visits to other facilities (including international locations) as well as the ability to work flexible hours.[48] The typical feeling employees are only productive if they are in their office needs to be changed to one where time is not wasted as long as it is spent thinking about work-related items.[49] The typical restrictive attitude is particularly dangerous because R&D is compartmentalized in large organizations.[50] To foster new ideas, supervisors must allow employees to visit users and provide employees the time they need to reflect.[51] Employees should be encouraged to walk around the block or engage in distractions to open their minds to creativity free flow.[52]

In addition to these approaches, perhaps one of the best ways to create the culture shift is to set an innovation challenge. A classic example is President John F. Kennedy's goal to land an American safely on the moon by the end of the decade.[53]

Once the challenge is set, then leadership must determine how to select the ideas to pursue more thoroughly. Ideas should be accepted from across the organization; then management should pick one idea to become a project.[54] Also, to eliminate even subconscious bias, the submitters' identities should be masked when ideas are reviewed. This practice will allow submissions from low-ranking or less-experienced individuals to have an unbiased review without possible elimination of novel ideas merely because they came from a source normally perceived as less knowledgeable than other employees.

With the projects selected, leadership must also provide resources for those programs. Traditionally, low funding creates resistance against innovation; calling for products to be "faster, better, and cheaper," meant one could pick two of those options, but it was not possible

to have all three.[55] Although, this presumption was proven false by the National Air and Space

Administration (NASA) Pathfinder program.[56] Thus, management may decide to provide

limited additional resources, but still anticipate innovation.[57] In contrast, AFRL must retain

sufficient funds to ensure the projects are documented, accessible, and searchable by others.

Thus, the organization cannot ignore the fact funding is needed to create a more innovative R&D

environment.

Then, once leadership sets the climate and provides resources, they must get out of the

way and accept risks, as management is sometimes the entity most resistant to change or new

ideas.[58] Creating an Office of Innovation focused on improving internal innovation

opportunities, not external projects, would also be productive.[59] This Office of Innovation would

be a specific entity with its sole focus on innovation, emphasizing leadership's commitment.[60] In

addition, one way to announce the ribbon-cutting of this office would be to kick off with a

"topsy-turvy" Innovation Day.[61] This will integrate everyone, similar to a job fair or field trip

for personnel to see other areas of AFRL.[62]

AFRL also sets the organizational culture based on the personnel hired and retained.

Management needs to be open to "recruitment and retention of creative people and creation of a

working environment which encourages creativity."[63]

Personnel

Overall, organizations must invest in people, not in ideas.[64] One of the key ways to

attract high-caliber employees is to ensure the organization has a reputation of success, then

"success breeds success."[65] However, there are many barriers to obtaining this success. Leaders

need to remove obstructions as well as other barriers restricting originality.[66] In a government

organization, this undertaking may be more challenging than in other organizations as creativity

and authority often are incompatible.[67] Thus, creating a team removed from the "normal"

organizational structure may help create a more creative environment. Simply pulling

employees out of their normal working environment, making them answerable to a different

supervisor, and removal of management layers and extra duties may spark creativity.

However, this Innovation Team still needs a hierarchy structure with a decision maker at

the helm. The decision maker does not lead the team; instead, the individual acts more as a

sponsor or team manager. This person should be well respected in AFRL and an innovation

supporter with political savvy. [68] This team manager needs to be in place because, otherwise, the

entire program may evolve into chaos. However, the individual must not restrict the team from

pursuing novel areas. The decision maker should concentrate on obtaining resources, leaving

other scientists and engineers to work on the problem. Thus, this person will need authority to

obtain cooperation as well as resources throughout AFRL. One option is to assign a high-

ranking individual as the decision maker; but, it may be more ideal to have a young, new,

enthusiastic member involved.[69]

Within the team itself, no real lead should be appointed. As the project transitions

through different phases, different participants will naturally rise to take control of sections. This

lack of a designated leader means the team should be kept small, to avoid too many divergent

opinions being presented to the decision maker.[70] A plan of having no more than five core team

members is a good approximation, with additions of up to about ten more people as consultants

or tributary contributors. Even when starting with just a few individuals, their success will ripple

outward, inspiring innovation in others.[71]

But how does one know if the organization has the right people in it to begin with?

Innovation is more about who works for the organization than any other factor; thus, the most

important element for originality is to ensure there is a diverse pool of manpower.[72] In the engineering and science fields, some limiting areas in the manpower pool are gender and age gaps.[73] Therefore, an alternative way to improve diversity is to lower restrictions limiting collaboration with external organizations.[74] Consequently, the organization can improve its manpower diversity almost overnight. Working closely with external agencies, companies, and universities also reduces costs, risks, and time limitations – getting products out faster and cheaper.[75]

Besides diversity, another barrier to success is the employees' lack of unallocated time.[76] When administrative assistants were removed from offices, all of those administrative tasks did not disappear. Instead, scientists and engineers are now doing administrative tasks, such as dealing with travel processing in the Defense Travel System.[77] Thus, the first innovation challenge for a team to tackle could be a search for a way to give employees spare time back.[78]

It is inevitable innovators will also run into existing laws, regulations, and policies as barriers to their success. In this area, the decision maker will be key in advocating changes and exceptions to policy, requiring some very skilled persuasion. For example, the Innovation Team might work better if the walls are painted colors other than the typical shades of brown; but, these changes may require waivers from Air Force or Department of Defense Instructions. Or, the team may benefit from having pets with them at work, requiring waiver of the Federal Management Regulation regarding restrictions on animals in federal buildings.[79] Also, options to include interns and volunteers in the center may need high-level coordination because it could be an Anti-Deficiency Act violation to accept additional support.

Facilities

Concurrently, to promote the Innovation Team working at its best, AFRL must provide the team the facilities to do so. Leaders should create an alternative workplace focused on flexibility with a goal of promoting collaboration.[80] The design of the work space could include items typically not found in government buildings.[81] To be mobile and collaborative, team members may need laptops to move to different docking stations and internet access throughout the facility. The design could include creativity or collaboration rooms allowing participants maximum interaction, such as round conference tables, books, brainstorming tools such as whiteboards, as well as research databases.[82] In addition, the work space should be colorful including, if possible, sunlit areas.[83] Leaders will also need to remove distractions such as noise, discomfort, lack of resources, and needless interruptions.[84] Consider providing nap pods and play areas with emphasis on arousing all of the participants' senses (besides sight inputs, provide stimulating smells, music, and tactile surfaces).[85]

"If at first the idea is not absurd, then there will be no hope for it." - Albert Einstein[86]

Measuring and Analyzing Programs To Determine What Aspects Should Continue or Change

Considering these references on how leadership, personnel, and facilities can create innovative environments as well as the programs already enacted to improve innovation, AFRL can capitalize on the employees it already has to create a pilot program.[87] This pilot program will require a call for ideas, creation of an Innovation Center, an environment encouraging innovation, and a way to measure success.

Call for Ideas

First, AFRL leadership should announce the innovation challenge. As proposed earlier, perhaps the first goal should be how to give employees back their time.[88]

For the initial submissions, no one should guide the responses in any particular direction. This challenge for innovative solutions should go to all employees with submissions accepted without any filtering by management. Also, submissions should not be laborsome to create or require a great degree of detail. A spreadsheet to capture sample proposals may be the easiest method to receive the needed information, but not deter submitters.[89] Ideas for innovation projects should then be sanitized to remove the submitter's information. Core leaders in the AFRL front office should select a team to compare the submissions by creating a list of advantages and disadvantages for each idea as well as a matrix including a binary marking of whether it can be done in the timeframe, whether financial cost is low, and with other criteria considered necessary.[90]

Innovation Center

Once a project is selected, the AFRL Commander should create the Innovation Center. The Innovation Team should consist of the submitter of the idea, the decision maker, and personnel matrixed from the Directorates.[91] The submitter and matrixed personnel will form the core team, with this team including a diversity of skills and professions.[92] As the core team identifies others needed for the project, those personnel can be added as consultants or tributary contributors upon coordination with their supervisor. The ability for others to contribute to the project should be delegated to the lowest supervisory level to eliminate bureaucratic delays.[93] If outside agency assistance is desired, the decision maker should be authorized to explore and initiate those partnerships.

As appropriate, the Innovation Team should also include the interested customer for the project. By talking to the customer, the team can ensure the resulting solution or product will be compatible with field operations.[94] AFRL must be wary of this approach, however, as sometimes having the customer dictate the solution is not the best course of action.[95] Such an approach might close the team off from the best ideas simply by causing them to look only at solutions the customer has specifically identified.[96]

Another important aspect of the Innovation Team is it must have direct access to the AFRL Commander.[97] This access will establish the importance and recognition of the group; but, this does not mean the Innovation Team is micro-managed. The decision maker should be empowered to make most judgments, providing the Innovation Team resources needed to create solutions to the technological challenge.

Leadership also should provide the Innovation Team with all the AFRL employees' submissions not selected to be the pursued solution to the challenge. Other viewpoints will create discussions about alternative solutions they may not have considered. Furthermore, there should be a set time limit for the project.[98] A time limit will allow for prioritization of tasks, creating a drive to reach a solution.[99] Completion of the project may be defined as getting the project to a proof-of-concept demonstration phase; ensuring the endeavor is beyond the research stage, but not into prototype development.[100] However, there is a counterargument; some programs may require completion to the point of engineering development and production because foreign companies excel in those areas.[101] Each project will be unique, with many factors to consider in setting the time limit.[102]

As an alternative, instead of creating an internal Innovation Center, it may be possible to set up the team as an entrepreneurial company. It could be worked as an existing AFRL

Entrepreneurial Opportunities Program or in a manner with aspects borrowed from how the CIA created the non-profit In-Q-Tel program. For example, the General Instrument Company set up independent companies with fake stock and independence from their staff in order to create innovative projects.[103] This method is not recommended, though because innovation within AFRL is not improved—innovation within a separate company is.

Innovation Environment

In addition to forming the Innovation Center, leadership will want to create an innovation environment throughout AFRL. This environment can be created with time, awards, recognition, as well as toleration of risks or failures.

The first key to creating an innovative culture is giving employees the time to be creative. First, managers should encourage people to write down their ideas whenever they have them.[104] They also should let employees know when new calls for innovation projects will be coming. Then, employees must be given time to work on their ideas. Incorporating a program similar to the Google "20 percent time" program also is possible, but should probably be started with a "10 percent time" or "5 percent time" allocation. For example, every Monday, each supervisor can designate half of the employees work on "passion" projects in the morning, with the other half working on their projects in the afternoon, depending on what time of the day people feel most creative. This approach provides office coverage, but allows time for employees to work on their projects of interest.[105] If employees don't have innovation projects of their own, they should be encouraged to research areas interesting to them or visit other parts of the lab to learn about other projects.[106] This exposure to additional ideas may spark an idea of their own.

Leadership should also create an innovation environment by awarding originality.[107] The most obvious solution is to award innovation in performance appraisals.[108] AFRL already

rewards unique and overall contributions through its Fellows program, but this reward is based on publications as well as status in professional societies. It is a reward for a culmination of work, but does not focus on breakthrough or initial creativity. Thus, AFRL should find alternate ways to reward creativity. For example, AFRL should focus on naming discoveries after the researchers.[109] Using employees' names when talking about projects gives them pride of ownership. This simple approach can create a legacy, building on an innovative AFRL culture. Supervisors also should publicly acknowledge and promote ingenuity. A new award category to recognize innovation should be created, but AFRL should not dictate submission format, just distribute the criteria with a nomination deadline; thereby advancing support of creativity in the award itself.[110]

The other element of an innovation environment is toleration of failures or risks.[111] "One serious impediment for the creative individual is the fear of making a mistake and being criticized."[112] Leadership at all levels must suspend their judgment of creative ideas.[113] For example, the Hookless Fastener Company was selling 90 percent of their zippers for use in tobacco pouches.[114] To diversify the market need, one employee recommended using the zippers in men's pants instead of buttons, but the president of the company rejected this idea.[115] Consequently, it took four years to produce the first pair of zipper pants.[116]

Accordingly, supervisors should emphasize risk taking rather than playing it safe.[117] So, even though innovation is hopefully finding new ways to produce better results, the organization should give an award for the most unique approach to a problem.[118] This award could be given based on the submissions for the innovation challenge. Even if a project is not picked as the main focus for the Innovation Team, its unique perspective can still be rewarded; thus risk taking is rewarded.[119] Leaders should create an atmosphere where if you have "zero defects" then you

are not doing anything interesting.[120] In general, they should expect about half of the programs

to fail; the goal is not perfection.[121]

Measure Success

When considering this toleration of failure, it is imperative how AFRL defines

measurement of success. The organization must create a feedback loop to measure effectiveness

of its procedures. Additionally, leadership should determine what factors to measure, such as the

retention of personnel, cost savings, number of technologies transitioned to commercial industry,

number of items transitioned to a prototype stage, number who want to participate in innovation

programs, as well as number of ideas submitted to innovation challenges.[122] Other possible

factors to consider could also be how many products are fielded, number of patents, and license

fees from patents.[123] Really, the measures of success should be based on what AFRL defines as

"profitable."[124]

Managers also should schedule quarterly updates with annual reviews on innovation

projects. All employees should be invited to attend annual presentations; these public venues

should also be open to presentation of the "pet" projects being pursued outside of the Innovation

Center.[125] These presentations could be incorporated into the AFRL Inspire venue, a program

similar to the popular TED Talks. These presentations will spur new ideas. But, key to the

success of an innovation culture is leadership *must* attend.[126] Management must be seen as

actively involved; otherwise, attempts at continued creativity will fail.[127]

From this feedback measure of success, innovation can then become a continuous,

sustainable loop. Therefore, after the initial Innovation Center project is a success, a new

technology challenge should be issued.[128]

"The impossible is often the untried." - Jim Goodwin [129]

Conclusion

AFRL needs to find a way to provide new technology to its customers faster and cheaper. The way to achieve this goal is to create a culture of innovation within AFRL. A review of existing programs in the government and private industry provides some headway, but does not address the main component of changing an organization's culture to one embracing or creating self-sustaining innovation. By incorporating this review of other innovation programs and research on innovation literature, AFRL must concentrate on three primary areas. The first area is encouraging breakthrough innovative ideas with aspects drawn for other organizations' innovation and technology transfer programs. The second area is creating and maintaining facilities and personnel policies to inspire originality. Lastly, AFRL must critically assess and adapt the new programs to continually stimulate an innovation culture. Key to this cultural change should be an Innovation Center with corresponding projects and support. Who knows, perhaps AFRL will be the first to develop feasible teleporter technology! [130]

Notes

[1] Gijs van Wulfen, "25 Inspiring Innovation Quotes," accessed 25 September 2015, http://www.innovationexcellence.com/blog/2011/08/16/25-inspiring-innovation-quotes/.

[2] Since at least 2001, senior Department of Defense leaders have encouraged a culture of innovation. Craig Whittinghill, David Berkowitz, and Phillip Farrington, "Does Your CULTURE Encourage INNOVATION?," *Defense AR Journal* vol. 22, no. 2 (April 2015), 218. This push for innovation continues through today with a recent article from the Under Secretary of Defense for Acquisition, Technology, and Logistics. Frank Kendall, "Innovation in the Defense Acquisition Enterprise," *Defense AT&L Magazine* vol. XLIV, no. 6 (November-December 2015), 2-5.

[3] AFRL submitted the AURIMS topic. Also supported by "In 2006, the United States Air Force Scientific Advisory Board conducted a quick-look study on the use of System Level Experimentation (SLE) to encourage disruptive innovation (USAF SAB, 2006). The largely qualitative study found that while the Air Force is very good at sustaining innovation, its S&T community has largely lost its ability to foster disruptive innovation. Furthermore, the study stated Air Force S&T organizations have failed to take advantage of a strong existing contingent of innovative personnel and have not created an organizational environment to promote the emergence of game-changing ideas." David E. Shahady, "Understanding the Emergence of Disruptive Innovation in Air Force Science and Technology Organizations," (master's thesis, Air Force Institute of Technology, n.d.), 8-9, 93.

[4] Loosely based on (innovation = invention + exploitation). Ibid., 13.

[5] Joe Tidd, John Bessant, and Keith Pavitt, *Managing Innovation: Integrating Technological, Market and Organizational Change*, 2nd ed. (New York, NY: John Wiley & Sons, Ltd, 2001), 14.

[6] A variation of this quote is often attributed to Alan Kay, but first appeared in 1963 in the book "Inventing the Future" written by Dennis Gabor who was later awarded a Nobel Prize in Physics for his work in holography. Quote Investigator, "We Cannot Predict the Future, But We Can Invent It," accessed 12 February 2016, http://quoteinvestigator.com/2012/09/27/invent-the-future/.

[7] For a summary of innovation theories and application of theories to military innovation, specifically case studies of carrier aviation and mechanized warfare during World War II, see Mark E. Weatherington, "The Contest with Context: Theory and Military Innovation," (Air Force Fellows, Air University, April 2009). In addition, AFRL already has participate in several technology transfer programs with innovation aspects, such as Small Business Innovation Research, Small Business Technology Transfer, Dual-Use Science and Technology, Independent Research and Development, Technology Transfer through Cooperative Research and Development Agreements, Education Partnership Agreements, Commercial Test Agreements, Patent License Agreements, Technology Investment Agreements, and Partnership Intermediary Agreements. For more information on these programs, see Jonathan P. Manternach, "Technology Transfer Programs: An Inductive Analysis of Air Force Technology Transfer Programs," (master's thesis, Air Force Institute of Technology, March 2005). Additional review of the Air Force's Technology Transfer Program Office and Offices of Research and Technology Applications with examination of related laws, obstacles, best practices, and training can be found in David C. Trexler, "Technology Transfer: A Qualitative Analysis of Air Force Office of

Research and Technology Applications," (master's thesis, Air Force Institute of Technology, June 2006).

[8] "Our Culture," Google Company, accessed 12 October 2015, http://www.google.com/about/company/facts/culture/. Susan Wojcicki, "The Eight Pillars of Innovation," *Think Quarterly*, July 2011, https://www.thinkwithgoogle.com/articles/8-pillars-of-innovation.html, 34.

[9] "Our Culture," Google Company.

[10] Ibid.

[11] Ibid.

[12] Jonathan Strickland, "How the Googleplex Works," How Stuff Works, accessed 26 October 2015, http://computer.howstuffworks.com/googleplex.htm.

[13] Ibid.

[14] "Inside Google Workplaces, from Perks to Nap Pods," CBS News, 22 January 2013, accessed on 26 October 2015, http://www.cbsnews.com/news/inside-google-workplaces-from-perks-to-nap-pods/. Nancy Kwallek, Kokyung Soon, and Carol M. Lewis, "Work Week Productivity, Visual Complexity, and Individual Environmental Sensitivity in Three Offices of Different Color Interiors," *Color Research and Application* (April 2007), 141.

[15] Strickland, "How the Googleplex Works."

[16] Ibid.

[17] Ibid. "Inside Google Workplaces," CBS News. Sleep helps the brain to explore the full range of solutions to a problem and to detect patterns that the conscious mind fails to perceive. Thus, dreams are a chaotic, yet productive, way to explore difficult challenges. Steven Johnson, *Where Good Ideas Come From: The Natural History of Innovation* (New York, NY: Riverhead Books, 2010), 102.

[18] Strickland, "How the Googleplex Works." Wojcicki, "The Eight Pillars of Innovation," 35. Google's program was modeled on a similar program at 3M and is officially called "Innovation Time Off." Johnson, *Where Good Ideas Come From*, 93. Marissa Mayer, when she was Google's Vice President of Search Products and User Experience, claimed over 50 percent of Google's new products came from Innovation Time Off projects. Ibid., 94.

[19] John C. Gannon, "The Strategic Use of Open-Source Intelligence," in Roger Z. George and Robert D. Kline, eds., *Intelligence and the National Security Strategist: Enduring Issues and Challenges* (Washington, D.C.: National Defense University Press, 2004), 283.

[20] Ibid.

[21] Success means the technology resulted in a fielded product. Robert K. Yin, Karen A. Heald, Mary E. Vogel, Patricia D. Fleischauer, and Bruce C. Vladeck, *A Review of Case Studies of Technological Innovations in State and Local Services*, (Santa Monica, CA: RAND, February 1976), 104. These results reinforce the adage "you need power to implement results." Ibid., 107.

[22] Start-up companies receive more funding from venture capitalists for technology with promising commercial applications since there is the likelihood of a higher return on investment than if the technology is only useful for government applications.

[23] Gannon, "The Strategic Use of Open-Source Intelligence," 283.

[24] "Press Release 11-153, I-Corps: To Strengthen the Impact of Scientific Discoveries," National Science Foundation, accessed 12 October 2015, http://www.nsf.gov/news/news_summ.jsp?cntn_id=121225.

[25] Ibid. In addition, AFRL is currently working with the Dayton Development Coalition (DDC) in Ohio on a similar project.

[26] Ibid.

[27] "Factsheet: I-Corps Program," National Science Foundation, accessed 26 October 2015, http://www.nsf.gov/news/special_reports/i-corps/pdf/factsheet_teams.pdf. "About I-Corps," National Science Foundation, accessed 26 October 2015, http://www.nsf.gov/news/special_reports/i-corps/about.jsp.

[28] "Technology Transfer Program," Department of Homeland Security, accessed 12 October 2015, https://www.dhs.gov/science-and-technology/technology-transfer-program.

[29] "Business Opportunities," Department of Homeland Security, accessed 12 October 2015, https://www.dhs.gov/science-and-technology/business-opportunities.

[30] For discussions on how major technology advancements are happening quicker and graphs showing how technology growth is moving at an exponential rate, see Ray Kurzweil, *The Singularity is Near* (New York, NY: Viking Books, 2005).

[31] Daniel Oyon, "Why Innovate? The Impact of Innovation on Firm Performance," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 1 (Westport, CT: Praeger Publishers, 2007), 9. Also, at least one study showed that two-thirds of the study participants stated innovation is a primary decision factor when applying for and retaining jobs. Amanda McGrory-Dixon, "Millennials Say Organizations Must Encourage Innovation," *Benefits Selling Breaking News* (24 January 2013), http://www.benefitspro.com/2013/01/24/millennials-say-organizations-must-encourage-innov.

[32] AFRL SOP 36-001, "Entrepreneurial Opportunities Program for AFRL Scientists and Engineers," AFRL Entrepreneurial Opportunities Program, August 2015.

[33] Ibid.

[34] FY16 National Defense Authorization Act (Items of Interest), "Entrepreneurial Sabbatical for Department of Defense Laboratory Scientists," 69.

[35] One recruitment tool would be former AFRL employees who took advantage of the program encouraging others to apply to join AFRL because of their great experience while working there.

[36] Wulfen, "25 Inspiring Innovation Quotes."

[37] Martin Haemming, "Funding Innovation through Venture Capital: A Global Perspective," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 3 (Westport, CT: Praeger Publishers, 2007), 29. Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 1 (Westport, CT: Praeger Publishers, 2007), xii.

[38] Brian C. Twiss, *Managing Technological Innovation*, 2nd ed. (New York, NY: Longman Group Limited, 1980), 14.

[39] Jacob E. Goldman, "Innovation in Large Firms," in Richard S. Rosenbloom, ed., *Research on Technological Innovation, Management and Policy*, vol. 2 (Greenwich, CT: Jai Press Inc., 1985), 9. James D. Lang, "Creativity and Innovation in Defense Technology and Strategy," (master's thesis, Industrial College of the Armed Forces, April 1983), 47.

[40] Edward C. Staten, Jr., "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment," (research study, Air Command and Staff College, May 1975), 18.

[41] Tidd, Bessant, and Pavitt, *Managing Innovation*, 337. "The DoD's culture is influenced heavily by its famous hierarchical, mechanistic organizational structure….Therefore, one can reasonably conclude that the DoD's mechanistic structure and culture would inhibit innovativeness." Whittinghill, Berkowitz, and Farrington, "Does Your CULTURE Encourage INNOVATION?," 219. One of the ways current AFRL processes must change involves *removing* oversight. Until recently, in at least one AFRL Directorate personnel were required to have a supervisor sign a form before they could update their information, such as a new office or phone number, on the Global Address List. Other Air Force organizations allow personnel to directly update this information via a website link without supervisor approval. This example demonstrates a distinct lack of trust in AFRL; without a "culture of trust," innovation is limited because individual independence is stifled and employees are essentially trained to request permission before accomplishing even the simplest of tasks. If the goal is to promote innovation, AFRL must enable people to take risks; however, current policies and processes do not foster that underlying culture.

[42] In comparing the top creativity factors, their importance is broken down into the following percentages: freedom to work on areas of greatest interest (44%); recognition and appreciation 41%; broad contacts with stimulating colleagues (38%); and encouragement to take risks (26%). Other factors are: tolerance of non-conformity (12%); monetary rewards (8%); opportunity to work alone rather than in a team (3%); creativity training programs (2%); and criticism by supervisors or associates (1%). S.M. Parmenter and J.D. Garber, "Creative Scientists Rate Creativity Factors," *Research Management*, November 1972, in Brian C. Twiss, *Managing Technological Innovation*, 2nd ed. (New York, NY: Longman Group Limited, 1980), 74.

[43] In setting an innovation climate, another important role of leadership is to encourage humor. Val E. Hendrix, Daniel B. Chapla, and William Mizzelle, eds., *Creativity and Innovation in Bureaucracy Symposium* (Washington, DC: National Defense University, 1985), 14. A sense of humor encourages positive thinking; it is closely connected to the ability to think of new ideas. Ibid., 37. Thus, even professional organizations need levity. Leadership could consider opening meetings by asking for an attendee to tell everyone a good joke. Puns employees would tell their third graders are a good reference point for the appropriate type of humor that will not offend other attendees' sensibilities.

[44] Suzy Wetlaufer, "What's Stifling the Creativity at CoolBurst?," in *Harvard Business Review on Breakthrough Thinking* (Boston, MA: Harvard Business School Publishing, 1999), 142.

[45] John W. Haefele, *Creativity and Innovation* (New York, NY: Reinhold Publishing Corporation, 1962), 162-163. Many innovative breakthroughs are developed from an idea that has been in the back of someone's mind for years (a "slow hunch"), and not from "Eureka!" moments. "Sustaining the slow hunch is less a matter of perspiration than of *cultivation*. You give the hunch enough nourishment to keep it growing, and plant it in fertile soil, where its roots can make new connections. And then you give it time to bloom." Johnson, *Where Good Ideas Come From*, 78.

[46] Staten, "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment," 12. Leadership support for innovation is the attribute with the most influence on innovation, with the supply of resources being the second most important factor. Whittinghill, Berkowitz, and Farrington, "Does Your CULTURE Encourage INNOVATION?," 233. In addition to providing these resources, leadership must encourage

fostering the individual creative ideas. Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 3. "A review of the problems of innovation teams in large, middle-aged organizations reveals seven characteristics of successful innovation: senior management sponsorship and support; clear and appropriated goals; team selection and balance; intimacy with the market; flexible organizational structure; flexible controls and measurements; and appropriate incentives." R. Szakony, *Technology Management: Case Studies in Innovation*, (Boston, MA: Auerbach Publications, 1992), in Jonathan P. Manternach, "Technology Transfer Programs: An Inductive Analysis of Air Force Technology Transfer Programs," (master's thesis, Air Force Institute of Technology, March 2005), 108. "[A] thorough commitment in all layers of management is essential to foster creativity and to support those who are creative." Lang, "Creativity and Innovation in Defense Technology and Strategy," 37. To support this environment, the Air Force Institute of Technology already offers a course to explore the importance of creativity and innovation; the course is open to anyone who works in a public or private Science, Technology, Engineering, or Math environment. "Engineering Management (GEM)," Air Force Institute of Technology, accessed on 28 October 2015, http://www.afit.edu/ENV/programs.cfm?p=36&a=pd. "RDMT 541: Operational Technology and Innovation" (course syllabus, Air Force Institute of Technology, Winter Quarter 2015). Lang, "Creativity and Innovation in Defense Technology and Strategy," 37.

[47] Thomas Francis Sullivan, "Using Organizational Mechanisms to Encourage Innovation," (master's thesis, Naval Postgraduate School, September 1979), 11. Sometimes leaders may be unaware of what factors are the highest motivators and interests of their employees. Thus, when changing the culture of an organization, one of the first steps is to ask the employees what they want. Different people may have different preferences, and those inclinations may vary greatly, but leadership will obtain an idea of how to influence the culture by reviewing the employees' responses. Indeed, one must keep in mind, "Innovation can be encouraged, but not at gunpoint." Rod Pyle, *Innovation the NASA Way: Harnessing the power of Your Organization for Breakthrough Success* (New York, NY: McGraw-Hill Education, 2014), 4.

[48] Wetlaufer, "What's Stifling the Creativity at CoolBurst?," 130. Mel Horwitch and Kiyonori Sakakibara, "The Changing Strategy-Technology Relationship in Technology-Based Industries: A Comparison of the United States and Japan," in Richard S. Rosenbloom, ed., *Research on Technological Innovation, Management and Policy*, vol. 3 (Greenwich, CT: Jai Press Inc., 1986), 130. Staten, "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment," 21.

[49] Wetlaufer, "What's Stifling the Creativity at CoolBurst?," 130.

[50] Goldman, "Innovation in Large Firms," 3.

[51] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 242. Haefele, *Creativity and Innovation*, 101.

[52] Johnson, *Where Good Ideas Come From*, 110.

[53] Dana Baldwin, "Creating an Environment for Innovation," accessed 25 September 2015, http://www.cssp.com/CD0902/CreatingInnovativeEnvironment/default.php. Also supported by Shahady, "Understanding the Emergence of Disruptive Innovation in Air Force Science and Technology Organizations," 40.

[54] Ralf Sauter, "Management of Innovation and Product Development Processes," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing*

Innovative Organizations and People, vol. 3 (Westport, CT: Praeger Publishers, 2007), 235 Figure 11.2.

[55] Lang, "Creativity and Innovation in Defense Technology and Strategy," 34. Pyle, *Innovation the NASA Way*, 4.

[56] Through an innovative, reliable, and less expensive design, NASA landed a probe on Mars by bouncing the landing craft more than fifteen times before rolling to a stop, as opposed to conventional arresting rockets. Pyle, *Innovation the NASA Way*, 2, 4. Also, consider actually limiting the resources provided to create a product. Sometimes, when one does not have much to work with is when the most innovative solutions are created. For example, NASA used various technologies multiple times in the Saturn rocket engine because of weight and design restrictions; novel uses of fuel to cool components and spark ignitions were found despite limited resources. Pyle, *Innovation the NASA Way*, 111.

[57] However, the issue with limited budgets is employees who want to concentrate on innovative projects do not have the time because manpower is already limited so there is only time to work on necessary current projects. Department of Defense Research, Development, Test and Evaluation spending has decreased by a third from 2007 to 2015 when comparing current-year dollars of actual amount spent in 2006 and the requested budget for 2015. Marcus Weisgerber, "A Visual Look Inside DoD's 2015 Budget Proposal," *Defense News*, 10 March 2014. Those limitations also restrict the opportunity for creativity.

[58] Jeff Jarvis, *What Would Google Do?* (New York, NY: HarperCollins, 2009), 117.

[59] With a trusted employee in charge of this office, AFRL can be tolerant of any apparent lack of progress, as creativity needs freedom and direction. Haefele, *Creativity and Innovation*, 7, 62, and 184.

[60] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 5-6.

[61] Ibid., 13.

[62] One way to organize Innovation Day activities is to have a list of functions or offices people can visit at certain times. An organized itinerary will allow more employees to see more areas of AFRL and allow employees who are scheduled to present information or tours to also go to other areas of AFRL when they are not presenters themselves. Also, due to the nationwide locations of AFRL, remote video tours of different sites and discussions with employees at those sites might be useful, thus allowing California, Hawaii, New Mexico, New York, Ohio, Tennessee, Texas, and Virginia offices to collaborate.

[63] Twiss, *Managing Technological Innovation*, 12.

[64] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 107. Investing in the right people may require changes in hiring practices. Normally, AFRL hires employees based on what discipline their degree is, what degree level they earned, where they earned their degrees, and what GPAs they had. However, GPA may not be the best measure of innovation potential. Instead, GPA could be an indicator of a lack of creativity because the student was good at providing what "the system" wanted.

[65] Haefele, *Creativity and Innovation*, 189.

[66] Staten, "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment," 13.

[67] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 60.

[68] Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 24.

[69] In addition, the organization will need to consider appointing the lower-ranking employee, because if it ever wants to reduce the rank of the decision maker in the future, there is a real danger that "demotion" of the decision maker position may broadcast a perception the Innovation Team is losing status, importance, and priority.

It is important to note this organization is different from the AFRL Rapid Reaction Team (RRT). The RRT is an organization focused on quickly responding to high-priority, urgent customer requirements; it integrates existing technologies in new and different ways, leading to incremental improvements and not breakthrough innovations. Also, AFRL needs to consider how to make the entirety of AFRL innovative, not just an elite sub-section of the lab. AFRL should determine where it needs to have different policies than the Air Force, such as in contracting processes and requirements, money management, budget planning (POM or Program Objective Memorandum) processes, financial execution standards, etc. There are many areas where specialized rule sets unique to the laboratory environment could help encourage more innovation.

[70] R&D innovation units should be kept as small as possible. Walt W. Rostow, "The American Administrative Style: A Costly Inheritance," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993), 43.

[71] Charles H. Clark, *Idea Management: How to Motivate Creativity and Innovation* (New York, NY: American Management Association, 1980), 10. This limited team size will also limit the time needed from the AFRL Commander to meet with the team, a meeting required to provide the needed support and prestige to the program. The core team can always pull others into the team as consultants.

[72] Jessica Ruvinsky, "How Leaders Encourage Innovation," *Stanford Social Innovation Review*, vol. 9, iss. 4, 2001, 9-11. "Creative minds can discover our most exciting challenges, solve our toughest problems, and serve us when all else may seem to have failed." Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 3. "Breakthrough teams are composed of individual characters and diverse personalities deliberately recruited to generate energy and ideas (Kelley, 2000)." Shahady, "Understanding the Emergence of Disruptive Innovation in Air Force Science and Technology Organizations," 44. "…[I]nnovative environments are better at helping their inhabitants explore the adjacent possible, because they expose a wide and diverse sample of spare parts—mechanical or conceptual—and they encourage novel ways to recombining those parts. Environments that block or limit those new combinations—by punishing experimentation, by obscuring certain branches of possibility, by making the current state so satisfying that no one bothers to explore the edges—will, on average, generate and circulate fewer innovations than environments that encourage exploration." Johnson, *Where Good Ideas Come From*, 41.

[73] Underrepresented groups in Science, Technology, Engineering, and Math career fields include ethnic and racial minority groups, females, the economically disadvantaged, persons with disabilities, and people from rural or urban communities. National Science and Technology Council Committee on STEM Education, *The Federal Science, Technology, Engineering, and Mathematics (STEM) Education Portfolio: A Report from the Federal Inventory of STEM Education Fast-Track Action Committee* (Washington, DC: Office of Science and Technology Policy, December 2011), 17.

⁷⁴ Paul C. Light, *Sustaining Innovation: Creating Nonprofit and Government Organizations that Innovate Naturally* (San Francisco, CA: Jossey-Bass Publishers, 1998), 76.

⁷⁵ Tidd, Bessant, and Pavitt, *Managing Innovation*, 198.

⁷⁶ "These results support previous Air Force S&T findings indicating that AFRL personnel desire sense of freedom from bureaucratic constraints and non-value added work." Shahady, "Understanding the Emergence of Disruptive Innovation in Air Force Science and Technology Organizations," 75.

⁷⁷ JoAnn McCabe and Col John Wissler, "A Time Study of Scientists & Engineers (S&Es) in the Air Vehicles Directorate," *Defense AR Journal* vol. 17, no. 1 (January 2010), 127-140.

⁷⁸ Tackling the administrative tasks and finding more efficient methods and recommending tasks to be eliminated altogether will also help bolster the reputation of the organization and the Innovation Center. This increased reputation will breed more success and entice the best candidates to participate in it. "Rather than focusing narrowly on developing technologies and products, R&D needs to broaden its agenda, helping companies invent new practices and processes that enhance their overall ingenuity and flexibility." John Seely Brown and Robert Howard, "Research That Reinvents the Corporation," *Harvard Business Review* 80, no. 8, May 2009, 105.

⁷⁹ "What is the policy concerning dogs and other animals on Federal property? No person may bring dogs or other animals on Federal property for other than official purposes. However, a disabled person may bring a seeing-eye dog, a guide dog, or other animal assisting or being trained to assist that individual." Federal Management Regulation Section 102-74.425: Dogs and Other Animals, 22 September 2015, accessed 30 October 2015, http://www.gsa.gov/portal/ext/ public/site/FMR/file/Part102-_74.html/category/21859/#wp2017855.

⁸⁰ Mahlon Apgar IV, "The Alternative Workplace: Changing Where and How People Work," in Jane Henry and David Mayle, eds., *Managing Innovation and Change*, 2nd ed. (Thousand Oaks, CA: SAGE Publications Inc., 2002), 266. Wojcicki, "The Eight Pillars of Innovation," 35.

⁸¹ One building to consider drawing elements from is the Massachusetts Institute of Technology's Building 20. Originally designed to be a temporary structure, therefore built cheaply, the inhabitants were permitted to knock down and reconfigure walls to fit the workspace needed for specific projects. The fluidity of the building's interior structure encouraged innovation and collaboration. Johnson, *Where Good Ideas Come From*, 62-63.

⁸² Most important ideas emerge during gatherings of approximately a dozen researchers informally discussing their work. Ibid., 61. Drawings and symbols are good ways to spur creativity. Haefele, *Creativity and Innovation*, 48. Arthur B. VanGundy, *Idea Power: Techniques & Resources to Unleash the Creativity in Your Organization* (New York, NY: American Management Association, 1992), 11-12.

⁸³ Basically, to make a team creative, the organization should collect all the cool stuff and create an area where it is an honor, privilege, and joy to work. This environment will cause people to want to work there and be jealous of those who do. "What works for one company won't work for all. Take time to understand the essence of your culture and use it as inspiration to wear your heart on the walls. Whatever you do; do something, do it yourself, and involve your people in the process." Kursty Groves, "Room to Think," *Think Quarterly*, July 2011, 51.

⁸⁴ Staten, "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment," 22.

⁸⁵ Haefele, *Creativity and Innovation*, 57.

[86] Wulfen, "25 Inspiring Innovation Quotes."

[87] AFRL should consider starting this program at a location other than Wright-Patterson Air Force Base. This approach will ensure the process is "portable" at sites other than those co-located with headquarters AFRL and avoid the perception AFRL focuses on Wright-Patterson at the expense of other sites.

[88] By making the first project personal to the employees, it will build devotion to the new approach and people will want the recognition of helping others through a positive change. Also, a healthy "I beat the system" impression will spark further creative thinking.

[89] Over the course of development of this paper, it appears AFRL already initiated a process of this sort, as part of its "Year of Agile Business Practices" strategy. However, AFRL must make this an enduring practice and part of its culture, not a 1-year, "one and done" program.

[90] Arthur B. VanGundy, *Getting to Innovation: How Asking the Right Questions Generates the Great Ideas Your Company Needs* (New York, NY: American Management Association, 2007), 220-222. Alternatively, rather than management selecting the project for the Innovation Center or as a supplement to the submissions, an open platform may be developed for idea submission. This open platform of ideas could then be voted on by fellow AFRL employees. A design that allows for comments and responses and a button to mark approval of a proposal could help leadership determine which ideas may have the most support and help temper any management bias toward certain areas. This forum also should not publicly show ranks and identities, to avoid any personal biases other than critique of the idea. Idea Exchange is an example of this type of public forum, where one can see and improve on other people's suggestions. Johnson, *Where Good Ideas Come From*, 128. When selecting the project, leadership must remember most ideas are not mature when first proposed to management, and they need to ensure good ideas do not die on the vine prematurely. Lang, "Creativity and Innovation in Defense Technology and Strategy," 30.

[91] Derived from the notation about how leadership should encourage cross-training in VanGundy, *Idea Power*, 12.

[92] Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 23.

[93] "Military innovation is particularly affected by a bureaucratic structure…" Weatherington, "The Contest with Context," 3. To help encourage innovation, AFRL/RQ has a "Shark Tank" process modeled after the popular television show to encourage innovative projects. In implementing that program, leadership found supervisors were not allowing employees to use work time for their projects. Thus, RQ specified supervisors *must* allow employees at least eight hours per a pay period to work on a "Shark Tank" project.

[94] Also, the customer talks to other organizations and builds the reputation for AFRL and the Innovation Center. This reputation, in turn, can lead to increased or decreased funding and support. Jarvis, *What Would Google Do?*, 19.

[95] The quote often contributed to Henry Ford of "If I'd have asked the public what they wanted, I would have built a faster horse," comes to mind, but the origins of this quote are disputed. Quote Investigator, "My Customers Would Have Asked for a Faster Horse," accessed 12 February 2016, http://quoteinvestigator.com/2011/07/28/ford-faster-horse/.

[96] Ibid., 98.

[97] Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 15-17.

[98] The core team members will work toward the solution on a full-time basis, with contributions from others as approved by their supervisors.

[99] A time limit also opens the program to those who are not contributing to the current project to be looking forward to the next call for submissions.

[100] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 118.

[101] Lang, "Creativity and Innovation in Defense Technology and Strategy," 19. AFRL does not have authorities to take programs to engineering development and production. Indeed, AFRL may need higher Air Force support to field prototypes without first undergoing normal processes through development and operational testing.

[102] Although it shouldn't be advertised to the team, the time limit can always be extended if there is noticeable progress and benefits to the delay. However, these extensions should be used with care.

[103] Goldman, "Innovation in Large Firms," 9.

[104] Clark, *Idea Management*, 28-29. "…[P]art of the secret of hunch cultivation is simple: write everything down." Johnson, *Where Good Ideas Come From*, 83.

[105] VanGundy, *Idea Power*, 10.

[106] Johnson, *Where Good Ideas Come From*, 113.

[107] "Encouragement and rewards is important for idea generation, as cited by 39 percent of respondents, but only 20 percent of respondents say their employers use this tactic. Thirty-four percent of respondents also say offering employees free time for learning and creativity enhances innovation while only 17 percent of respondents say their employers practice this." McGrory-Dixon, "Millennials Say Organizations Must Encourage Innovation."

[108] "The employee's perception that they will receive recognition for significant contributions or outstanding performance—especially for creative or innovative pursuits—is important to creating a CE [corporate entrepreneurship] atmosphere. Kuratko, Ireland, Covin, and Hornsby (2005) noted that rewards and reinforcement are 'developing and using systems that reward based on performance, highlight significant achievements, and encourage pursuit of challenging work.' Twomey and Harris (2000) found a positive relationship between reward and recognition systems and CE behavior of employees—illustrating that an effective reward program promoted the entrepreneurial mindset." Wade W. Brower, "A Study of Corporate Entrepreneurship in a Department of Defense Organization" (master's thesis, Air Force Institute of Technology, March 2011), 8-9.

[109] Haefele, *Creativity and Innovation*, 24.

[110] Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 27. In addition, leaders should be open to other creative awards and incentives, too. Clark, *Idea Management*, 24.

[111] Light, *Sustaining Innovation*, 144-145. Wojcicki, "The Eight Pillars of Innovation," 36. "The history of being spectacularly right has a shadow history lurking behind it: a much longer history of being spectacularly wrong, again and again. And not just wrong, but *messy*." Johnson, *Where Good Ideas Come From*, 134.

[112] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 3.

[113] President George W. Bush challenged officers during a speech at the U.S. Naval Academy to "risk failure, because in failure, 'we will learn and acquire the knowledge that will make successful innovation possible.'" T. M. Williams, "Understanding Innovation," *Military Review* vol. 89, no. 4 (2009), 59, in Craig Whittinghill, David Berkowitz, and Phillip Farrington, "Does Your CULTURE Encourage INNOVATION?," *Defense AR Journal* vol. 22, no. 2 (April

2015), 218. "Being right keeps you in place. Being wrong forces you to explore." Johnson, *Where Good Ideas Come From*, 137.

[114] Clark, *Idea Management*, 18-19.

[115] He liked how his pants worked just as it was. Ibid.

[116] Ibid.

[117] Eric G. Glamholtz and Yvonne Randie, "How to Make Entrepreneurship Work in Established Companies," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993), 148.

[118] George Kozmetsky, "The Growth and Internationalization of Creative and Innovative Management," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993), 4. Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 15.

[119] VanGundy, *Idea Power*, 9.

[120] Hendrix, Chapla, and Mizzelle, *Creativity and Innovation in Bureaucracy Symposium*, 118.

[121] Lang, "Creativity and Innovation in Defense Technology and Strategy," 47. Light, *Sustaining Innovation*, 251. The goal is for innovation to become the norm and an expected activity. Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 27. To get to this innovation environment, leadership must design the program for longevity; otherwise, it will not last and become a part of the organization culture. Ibid., 33.

[122] Marc J. Epstein, "Drivers and Measures of Innovation Success," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 3 (Westport, CT: Praeger Publishers, 2007), 66-69. "Asian Innovation; Schumpeter," *The Economist*, no 8777 (24 March 2012), 68.

[123] Tidd, Bessant, and Pavitt, *Managing Innovation*, 145. Although, there are cautions against using patents as a measure of success. Petra Moser, "Patents and Innovation: Evidence from Economic History," *Journal of Economic Perspectives* vol. 27, no. 1 (Winter 2013), 24-25, 40. Ryan Lampe and Petra Moser, "Do Patent Pools Encourage Innovation? Evidence from the Nineteenth-Century Sewing Machine Industry," *The Journal of Economic History* vol. 70, no. 4 (December 2010), 898, 917. Due to classification issues, some innovative technologies might not be submitted for patents. Also, there is a trend in innovation culture toward the belief "intellectual property is no longer the key to success. Openness is." Jarvis, *What Would Google Do?*, 4. "Organizations like IBM and Procter & Gamble, who have a long history of profiting from patented, closed-door innovations, have embraced open innovation platforms over the past decade, sharing their leading-edge research with universities, partners, suppliers, and customers." Johnson, *Where Good Ideas Come From*, 125. "Patent Quality Makeover: IBM Hopes Improvement Initiative Will Drive U.S. Innovation," *Industrial Engineer*, vol. 38, no. 4, April 2006, 17. Thus, partnerships with outside organizations may be an element to capture in measuring success more than the number of patents sought or granted.

[124] J.S. Metcalfe and M. Gibbons, "Technology, Variety and Organization: A Systematic Perspective on the Competitive Process," in Richard S. Rosenbloom and Robert A. Burgelman, eds., *Research on Technological Innovation, Management and Policy*, vol. 4 (Greenwich, CT: Jai Press Inc., 1989), 156.

[125] It is important to maintain communication between the standard organization and the innovative organization. Lang, "Creativity and Innovation in Defense Technology and Strategy," 45.

[126] Joanna Barsh, Marla M. Capozzi, and Jonathan Davidson, "Leadership and Innovation," *McKinsey Quarterly,* January 2008, accessed 25 September 2015, http://www.mckinsey.com/insights/innovation/leadership_and_innovation.

[127] Sullivan, "Using Organizational Mechanisms to Encourage Innovation," 11.

[128] By this time, ideally employees will feel a committed investment in the Innovation Center. This challenge could look at what solution would have the most impact on the Air Force, such as a challenge for how to reduce transportation aircraft fuel costs.

[129] Wulfen, "25 Inspiring Innovation Quotes."

[130] Test results achieving quantum teleportation. "Unconditional Quantum Teleportation between Distant Solid-State Quantum Bits," *Science*, vol. 345, no. 6196, 1 August 2014, 532-535.

Bibliography

"About I-Corps," National Science Foundation, accessed 26 October 2015,
   http://www.nsf.gov/news/special_reports/i-corps/about.jsp.

AFRL SOP 36-001, "Entrepreneurial Opportunities Program for AFRL Scientists and
   Engineers," AFRL Entrepreneurial Opportunities Program, August 2015.

Mahlon Apgar IV, "The Alternative Workplace: Changing Where and How People Work," in
   Jane Henry and David Mayle, eds., *Managing Innovation and Change*, 2nd ed. (Thousand
   Oaks, CA: SAGE Publications Inc., 2002).

"Asian Innovation; Schumpeter," *The Economist*, no 8777 (24 March 2012).

Dana Baldwin, "Creating an Environment for Innovation," accessed 25 September 2015,
   http://www.cssp.com/CD0902/CreatingInnovativeEnvironment/default.php.

Joanna Barsh, Marla M. Capozzi, and Jonathan Davidson, "Leadership and Innovation,"
   McKinsey Quarterly, January 2008, accessed 25 September 2015,
   http://www.mckinsey.com/insights/innovation/leadership_and_innovation.

Wade W. Brower, "A Study of Corporate Entrepreneurship in a Department of Defense
   Organization" (master's thesis, Air Force Institute of Technology, March 2011).

John Seely Brown and Robert Howard, "Research That Reinvents the Corporation," *Harvard
   Business Review* 80, no. 8, May 2009.

"Business Opportunities," Department of Homeland Security, accessed 12 October 2015,
   https://www.dhs.gov/science-and-technology/business-opportunities.

Charles H. Clark, *Idea Management: How to Motivate Creativity and Innovation* (New York,
   NY: American Management Association, 1980).

Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing
   Innovative Organizations and People*, vol. 1 (Westport, CT: Praeger Publishers, 2007).

"Engineering Management (GEM)," Air Force Institute of Technology, accessed on 28 October
   2015, http://www.afit.edu/ENV/programs.cfm?p=36&a=pd. "RDMT 541: Operational
   Technology and Innovation" (course syllabus, Air Force Institute of Technology, Winter
   Quarter 2015).

Marc J. Epstein, "Drivers and Measures of Innovation Success," in Tony Davila, Marc J.
   Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative
   Organizations and People*, vol. 3 (Westport, CT: Praeger Publishers, 2007).

"Factsheet: I-Corps Program," National Science Foundation, accessed 26 October 2015,
   http://www.nsf.gov/news/special_reports/i-corps/pdf/factsheet_teams.pdf.

Federal Management Regulation Section 102-74.425: Dogs and Other Animals, 22 September 2015, accessed 30 October 2015, http://www.gsa.gov/portal/ext/public/site/FMR/file/Part102-_74.html/category/21859/#wp2017855.

FY16 National Defense Authorization Act (Items of Interest), "Entrepreneurial Sabbatical for Department of Defense Laboratory Scientists."

John C. Gannon, "The Strategic Use of Open-Source Intelligence," in Roger Z. George and Robert D. Kline, eds., *Intelligence and the National Security Strategist: Enduring Issues and Challenges* (Washington, D.C.: National Defense University Press, 2004).

Eric G. Glamholtz and Yvonne Randie, "How to Make Entrepreneurship Work in Established Companies," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993).

Jacob E. Goldman, "Innovation in Large Firms," in Richard S. Rosenbloom, ed., *Research on Technological Innovation, Management and Policy*, vol. 2 (Greenwich, CT: Jai Press Inc., 1985).

Kursty Groves, "Room to Think," *Think Quarterly*, July 2011.

John W. Haefele, *Creativity and Innovation* (New York, NY: Reinhold Publishing Corporation, 1962).

Martin Haemming, "Funding Innovation through Venture Capital: A Global Perspective," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 3 (Westport, CT: Praeger Publishers, 2007).

Val E. Hendrix, Daniel B. Chapla, and William Mizzelle, eds., *Creativity and Innovation in Bureaucracy Symposium* (Washington, DC: National Defense University, 1985).

Mel Horwitch and Kiyonori Sakakibara, "The Changing Strategy-Technology Relationship in Technology-Based Industries: A Comparison of the United States and Japan," in Richard S. Rosenbloom, ed., *Research on Technological Innovation, Management and Policy*, vol. 3 (Greenwich, CT: Jai Press Inc., 1986).

"Inside Google Workplaces, from Perks to Nap Pods," CBS News, 22 January 2013, accessed 26 October 2015, http://www.cbsnews.com/news/inside-google-workplaces-from-perks-to-nap-pods/.

Jeff Jarvis, *What Would Google Do?* (New York, NY: HarperCollins, 2009).

Steven Johnson, *Where Good Ideas Come From: The Natural History of Innovation* (New York, NY: Riverhead Books, 2010).

Frank Kendall, "Innovation in the Defense Acquisition Enterprise," *Defense AT&L Magazine* vol. XLIV, no. 6 (November-December 2015).

George Kozmetsky, "The Growth and Internationalization of Creative and Innovative Management," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993).

Ray Kurzweil, *The Singularity is Near* (New York, NY: Viking Books, 2005).

Nancy Kwallek, Kokyung Soon, and Carol M. Lewis, "Work Week Productivity, Visual Complexity, and Individual Environmental Sensitivity in Three Offices of Different Color Interiors," *Color Research and Application* (April 2007).

Ryan Lampe and Petra Moser, "Do Patent Pools Encourage Innovation? Evidence from the Nineteenth-Century Sewing Machine Industry," *The Journal of Economic History* vol. 70, no. 4 (December 2010).

James D. Lang, "Creativity and Innovation in Defense Technology and Strategy" (master's thesis, Industrial College of the Armed Forces, April 1983).

Paul C. Light, *Sustaining Innovation: Creating Nonprofit and Government Organizations that Innovate Naturally* (San Francisco, CA: Jossey-Bass Publishers, 1998).

JoAnn McCabe and Col John Wissler, "A Time Study of Scientists & Engineers (S&Es) in the Air Vehicles Directorate," *Defense AR Journal* vol. 17, no. 1 (January 2010).

Amanda McGrory-Dixon, "Millennials Say Organizations Must Encourage Innovation," *Benefits Selling Breaking News* (24 January 2013), http://www.benefitspro.com/2013/01/24/ millennials-say-organizations-must-encourage-innov.

Jonathan P. Manternach, "Technology Transfer Programs: An Inductive Analysis of Air Force Technology Transfer Programs," (master's thesis, Air Force Institute of Technology, March 2005).

J.S. Metcalfe and M. Gibbons, "Technology, Variety and Organization: A Systematic Perspective on the Competitive Process," in Richard S. Rosenbloom and Robert A. Burgelman, eds., *Research on Technological Innovation, Management and Policy*, vol. 4 (Greenwich, CT: Jai Press Inc., 1989).

Petra Moser, "Patents and Innovation: Evidence from Economic History," *Journal of Economic Perspectives* vol. 27, no. 1 (Winter 2013).

National Science and Technology Council Committee on STEM Education, *The Federal Science, Technology, Engineering, and Mathematics (STEM) Education Portfolio: A Report from the Federal Inventory of STEM Education Fast-Track Action Committee* (Washington, DC: Office of Science and Technology Policy, December 2011).

"Our Culture," Google Company, accessed 12 October 2015, http://www.google.com/about/ company/facts/culture/.

Daniel Oyon, "Why Innovate? The Impact of Innovation on Firm Performance," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 1 (Westport, CT: Praeger Publishers, 2007).

S.M. Parmenter and J.D. Garber, "Creative Scientists Rate Creativity Factors," *Research Management*, November 1972, in Brian C. Twiss, *Managing Technological Innovation*, 2nd ed. (New York, NY: Longman Group Limited, 1980).

"Patent Quality Makeover: IBM Hopes Improvement Initiative Will Drive U.S. Innovation," *Industrial Engineer*, vol. 38, no. 4, April 2006.

"Press Release 11-153, I-Corps: To Strengthen the Impact of Scientific Discoveries," National Science Foundation, accessed 12 October 2015, http://www.nsf.gov/news/news_summ.jsp?cntn_id=121225.

Rod Pyle, *Innovation the NASA Way: Harnessing the power of Your Organization for Breakthrough Success* (New York, NY: McGraw-Hill Education, 2014).

Quote Investigator, "My Customers Would Have Asked for a Faster Horse," accessed 12 February 2016, http://quoteinvestigator.com/2011/07/28/ford-faster-horse/.

Quote Investigator, "We Cannot Predict the Future, But We Can Invent It," accessed 12 February 2016, http://quoteinvestigator.com/2012/09/27/invent-the-future/.

Walt W. Rostow, "The American Administrative Style: A Costly Inheritance," in Robert Lawrence Kuhn, ed., *Generating Creativity and Innovation in Large Bureaucracies* (Westport, CT: Quorum Books, 1993).

Jessica Ruvinsky, "How Leaders Encourage Innovation," *Stanford Social Innovation Review*, vol. 9, iss. 4, 2001.

Ralf Sauter, "Management of Innovation and Product Development Processes," in Tony Davila, Marc J. Epstein, and Robert Shelton, eds., *The Creative Enterprise: Managing Innovative Organizations and People*, vol. 3 (Westport, CT: Praeger Publishers, 2007).

David E. Shahady, "Understanding the Emergence of Disruptive Innovation in Air Force Science and Technology Organizations," (master's thesis, Air Force Institute of Technology, n.d.).

Edward C. Staten, Jr., "A Practical Approach to Fostering and Channelizing Creativity and Innovation within the Air Force Work Environment" (research study, Air Command and Staff College, May 1975).

Jonathan Strickland, "How the Googleplex Works," How Stuff Works, accessed 26 October 2015, http://computer.howstuffworks.com/googleplex.htm.

Thomas Francis Sullivan, "Using Organizational Mechanisms to Encourage Innovation" (master's thesis, Naval Postgraduate School, September 1979).

R. Szakony, *Technology Management: Case Studies in Innovation*, (Boston, MA: Auerbach Publications, 1992), in Jonathan P. Manternach, "Technology Transfer Programs: An Inductive Analysis of Air Force Technology Transfer Programs," (master's thesis, Air Force Institute of Technology, March 2005).

"Technology Transfer Program," Department of Homeland Security, accessed 12 October 2015, https://www.dhs.gov/science-and-technology/technology-transfer-program.

Joe Tidd, John Bessant, and Keith Pavitt, *Managing Innovation: Integrating Technological, Market and Organizational Change*, 2nd ed. (New York, NY: John Wiley & Sons, Ltd, 2001).

David C. Trexler, "Technology Transfer: A Qualitative Analysis of Air Force Office of Research and Technology Applications," (master's thesis, Air Force Institute of Technology, June 2006).

Brian C. Twiss, *Managing Technological Innovation*, 2nd ed. (New York, NY: Longman Group Limited, 1980).

"Unconditional Quantum Teleportation between Distant Solid-State Quantum Bits," *Science*, vol. 345, no. 6196, 1 August 2014, 532-535.

Arthur B. VanGundy, *Getting to Innovation: How Asking the Right Questions Generates the Great Ideas Your Company Needs* (New York, NY: American Management Association, 2007).

Arthur B. VanGundy, *Idea Power: Techniques & Resources to Unleash the Creativity in Your Organization* (New York, NY: American Management Association, 1992).

Mark E. Weatherington, "The Contest with Context: Theory and Military Innovation," (Air Force Fellows, Air University, April 2009).

Marcus Weisgerber, "A Visual Look Inside DoD's 2015 Budget Proposal," *Defense News*, 10 March 2014.

Suzy Wetlaufer, "What's Stifling the Creativity at CoolBurst?," in *Harvard Business Review on Breakthrough Thinking* (Boston, MA: Harvard Business School Publishing, 1999).

Craig Whittinghill, David Berkowitz, and Phillip Farrington, "Does Your CULTURE Encourage INNOVATION?," *Defense AR Journal* vol. 22, no. 2 (April 2015).

T. M. Williams, "Understanding Innovation," *Military Review* vol. 89, no. 4 (2009), in Craig Whittinghill, David Berkowitz, and Phillip Farrington, "Does Your CULTURE Encourage INNOVATION?," *Defense AR Journal* vol. 22, no. 2 (April 2015).

Susan Wojcicki, "The Eight Pillars of Innovation," *Think Quarterly*, July 2011, https://www.thinkwithgoogle.com/articles/8-pillars-of-innovation.html.

Gijs van Wulfen, "25 Inspiring Innovation Quotes," accessed 25 September 2015, http://www.innovationexcellence.com/blog/2011/08/16/25-inspiring-innovation-quotes/.

Robert K. Yin, Karen A. Heald, Mary E. Vogel, Patricia D. Fleischauer, and Bruce C. Vladeck, *A Review of Case Studies of Technological Innovations in State and Local Services*, (Santa Monica, CA: RAND, February 1976).